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GB 2285940 A GB 1150382 A US 3872904 A

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(54) Abstract Title
Stepped driving recess and driving tool for a fastener

(57) A driving recess for a fastener 9 comprises a series of stepped hexagonal recesses 1,2,3 of different sizes in axial alignment, one on top of the other. For smaller fasteners (7,8, Figs 1,2) a single recess (1) or two recesses (1,2) can be provided. A single tool (4, Fig 4) with stepped hexagonal projections (4,5,6) will fit all arrangements. The recesses 1,2,3 are formed cold using a punch, which does not require taper. Therefore the sides of the recesses 1,2,3 are formed parallel with the axis of the fastener.

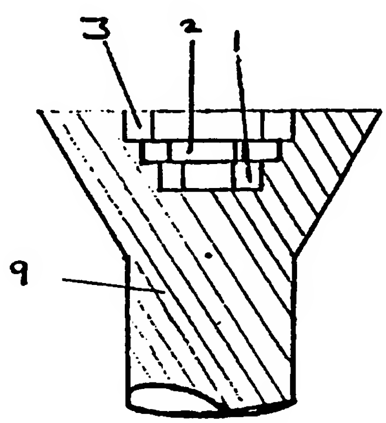

FIG. 3.

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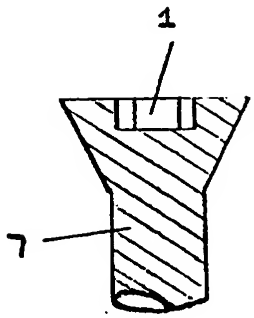

Fig 1

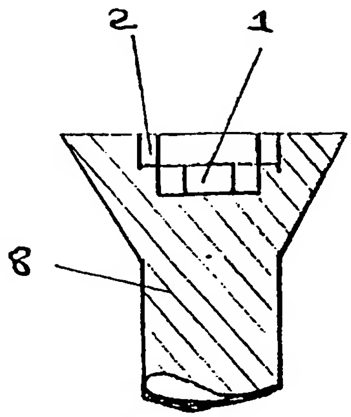

Fig. 2

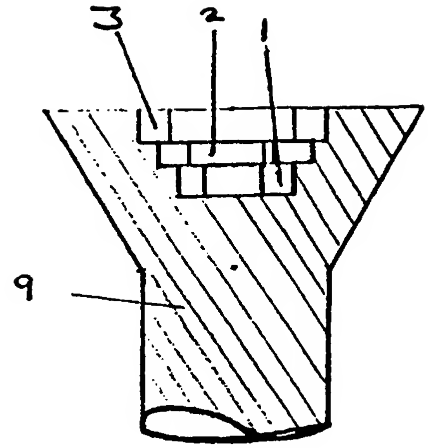

Fig. 3.

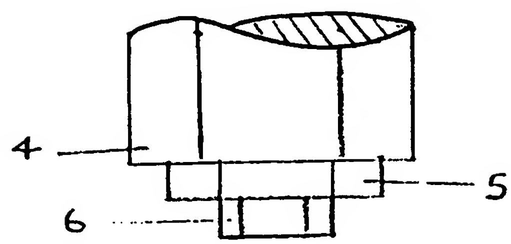

Fig. 4.

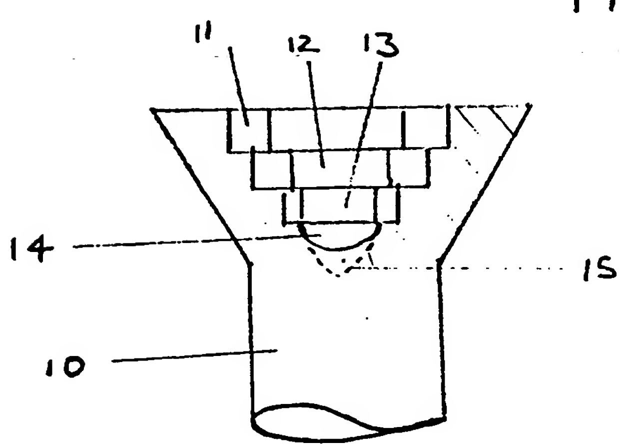

Fig. 5.

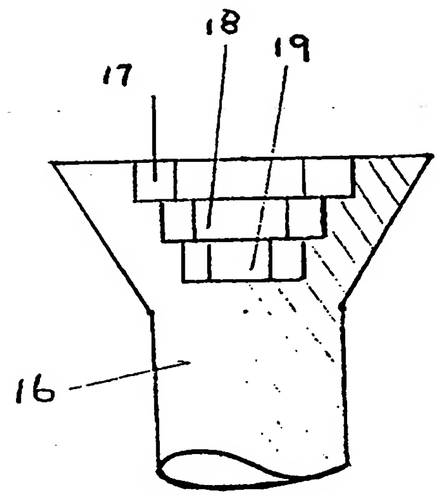

Fig. 6.

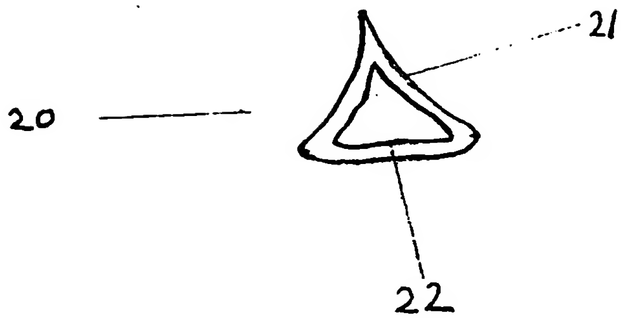

FIG. 7.

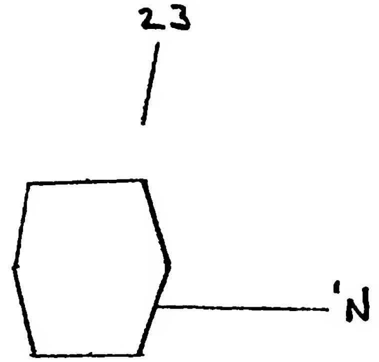

FIG. 8.

IMPROVEMENTS IN DRIVING HEADS FOR FASTENERS

This invention relates more particularly to the 'torque receiving element' (hereinafter refereed to as a 'driving head') of fastenings which require rotation in order to install them.
Generally such fasteners, e.g. bolts, screws etc., are threaded. However, it is envisaged that this invention might also be applied to non-threaded fasteners where their function is dependent upon rotation about their longitudinal axis.

Despite a vast range of driving heads being utilized for such fasteners, significant shortcomings still remain with all the systems known to the applicants.

A major objection to existing driving heads is that, since their size has to be matched to the torque required to install the fastener of which they form part, a range of mating drivers is also required. Frequently, 'makeshift' drivers are used which damage the driving heads of the fasteners concerned.

Furthermore,. all types of driving heads known to the applicants which utilize a recessed feature suffer from the disadvantageous phenomenon known as 'cam-out'. This describes the tendency of the driver and mating recess to move axially apart under an applied torque as a result of the torque transmitting forces being inclined at a small angle to the longitudinal axis of the fastener. Such inclination of the faces facilitated the extraction of the punch used to form the recess in manufacture. Failure to provide sufficient angle of release, commonly known as 'draw' in the heading trade, results in damage to the punch and/or the recess being formed.

Cam-out requires the operator to apply a counterbalancing force to the driver, which results in operator fatigue. Where there is an imbalance between the two forces, the driver moves axially out of the recessed feature, causing wear to the engaging faces of the driver and recess as well as possible damage to the adjoining surfaces.

Another disadvantage of draw is that mere insertion of a driver into a recessed driving head will not allow a free fastener to be carri d vertically by frictional contact between the driver and recess. The ability to insert a fastener into certain locations would be greatly facilitated if the driver could carry the fastener on its extremity, so assisting the remot installation of a fastener.

A further problem, experienced when recessed driving heads are utilized on fasteners incorporating a conical or countersunk heads, is that the head tends to shear from the shank of the fastener when torque is applied. This is due to the bottom of the driving recess reaching to the plane passing through the minor diameter of the conical head; thus reducing excessively the cross-sectional area of the fastening at this point.

The object of the invention is to overcome the shortcomings experienced when a recessed driving head is utilized. A recessed driving head is defined as a torque receiving feature provided in a fastener, which is designed to be of a generally complementary form to a male torque delivering driver. Typical, well known recessed driving heads are: hexagonal recessed, spline-drive recesses and proprietary recesses such as 'Philips' or 'posidrive'. The common cross-head in a normal wood screw is another common recessed driving head.

The invention comprises a method of transmitting torque to a range of differentially sized fasteners using one driver. The system comprises:

1. A driver heaving at least two adjacent male driving elements, aligned axially and with the overall dimensions of the said elements, measured radially, progressively reducing to the free end of the driver.

2. The smaller fasteners in the range have at least one complementary female recess corresponding to the smallest stepped portion of the driver and possibly further, radially enlarging, recesses to mate with additional complementary elements of the driver, depending upon the size of the fastener.

3. The largest fastener in the range will fully engage with all the stepped elements of the driver. The extreme free end of the male driver may be provided with a tapered 'pilot' or rounded post which mates with a complementary cavity beyond the smallest element of the female recess.

4. With regard to the actual configuration of the female recesses used in fasteners manufactured in accordance with the above plan, any recess capable of accepting torque from a complementary driver is acceptable. Thus any of the accepted patterns, such as hexagons, squares, straight slots, splines etc. can be utilized. The only restriction is that a female recess must have a constant sectional form over its total depth, measured along the axis of the fastener. A female recess with a 'posidrive' (Trade Mark) form would therefore be unsuitable, since the torque transmitting faces converge. In other words, th only female recesses suitable for us in this inv ntion ar thos

which, if formed in material of equal depth to the recess, would allow access to the driver from either end.

Fasteners produced according to this invention can hav a range of diameters and yet all be driven by one male driver, the form of which is complementary to the female recess provided in the largest diameter fastener of the series. When using the same driver for the smaller fasteners in the series, only those portions or elements of the stepped driver which enter the female recess are employed to transmit torque. Thus, as the diameter and length of the head of a fastener decrease, the number of elements used in the female recess must also decrease, since there is less room available for the recess. Although fewer elements are used the reduced torque receiving capacity of their female recess is matched to the maximum torque that can be safely applied to the smaller fastener.

It will be apparent from the foregoing, therefore, that the same driver can be used for driving smaller and smaller fasteners until only the smallest element of the driver is being used to transmit torque. The limit to the continuing use of the driver is reached when the head of the fastener becomes so small that it can no longer accommodate the smallest element of the male driver.

The invention will thus enable substantial reductions in tool inventories to be achieved and reduce the incidence of damage to fasteners occurring through the use of improper or incorrect tools.

Normally, the recess in the head of a fastener is formed by a process involving the projection of a male counterpart, known as a punch, into the head. This process is known as cold-heading. It has previously been stated that a few degrees of taper are necessary on this punch, the smallest portion of the punch being that which first enters the fastener. Without this taper, or draw, the slight elastic recovery of the fastener material, after the punch has come to rest results in the punch being gripped in the fastener. The outcome is that stresses are set up in the punch, leading to premature failure. The finish of the female recess can also become coarsened.

The tapering of the female recess caused by draw on the punch also means that the driver cannot be used as a locating tool to place a fastener, previously lodged on its tip, into a otherwise inaccessible hole, this is due to the ready separation of the male driver from the female recess.

However, with fasteners manufactured in accordance with the present invention it has been found possible to dispense with draw on the punch s us d in the cold-heading operation. This surprising result has been proved under actual manufacturing conditions.

A possible hypothesis is that the total depth of the f mal recess is broken into at least two, and sometimes three or more elements with differing axial cross sections. Therefore, the punch does not have to retract far before there is considerable clearance between it and the female recess. This explanation should not, however, be regarded as defining the true reason for the satisfactory working of a punch with no draw, but as a possible explanation.

Since the individual elements of the female recess are produced without draw, these fasteners do not subject the male driver to cam-out forces. Male driver wear is therefore considerably reduced, operator fatigue lessened and the possibility of workpiece damage obviated. Also, the fastener tends to be held onto the driver by frictional forces, allowing for easy placement in otherwise inaccessible locations. Certain known types of recess configurations can, in fact, be utilized to enhance the frictional engagement between the driver and recess.

It is decided to produce the female recess with zero or minimal draw, then difficulty may be encountered in readily entering the driver into such a recess. This particularly applies when the smallest element of the male driver commences to enter its complementary recess in the fastener. The provision of a round, tapering or domed protrusion on the extreme end of the driver, after the smallest driving element, can be used to assist in aligning the axis of the driver with that of the fastener recess. To accomplish this with the most facility, the maximum outside diameter of the protrusion must be a close sliding fit in the smallest element of the female recess. Once axially aligned, rotation of the driver relative to the fastener will result in the torque transmitting features of the driver and recess becoming aligned, thus allowing axial sliding engagement to take place.

The torque transmitting features of the separate elements of the male driver need not necessarily be aligned with each other, as long as the female recess preserves the same alignment. Normally, the torque transmitting features will be aligned, so each driver will engage with every recess. However, there could be any standardized relationship between the torque transmitting features of a driver and a complementary set of fasteners.

Also, different types of torque transmitting elements could be used for the various sizes of elements on a male driver, thus enabling only female recesses with the same configuration as that of the driver to mate. Use of the twin variables of alignment and types of torque transmitting element employed can 'key' the driver for use only in conjunction with fasteners having the same configuration. Such features are of value when certain fasteners must only be released by delegated personnel.

Unlike a normal female recess, this new configuration can be used in conical-headed fasteners without exc ssively weakening the fastener in the vicinity of the junction of the head and shank. A posidrive (Reg. TM) type rec ss, although tapering axially to a certain xtent, still leads to an excessive reduction in wall thickness at the head-shank junction. Appropriate selection of the dimensional steps between the various elements of a female recess produced according to this invention will ensure that the fastener has no axial positions of weakness.

Typical embodiments of the invention are now described in detail with reference to the accompanying drawings:

Figure 1 is an axial section through the smallest fastener in a series having a single hexagonal female recess.

Figure 2 is an axial section of an intermediate sized fastener in a series having two different 'tiered' sizes of female recess.

Figure 3 Is an axial section of the largest fastener in a series having three different 'tiered' sizes of female recess.

Figure 4 shows a side elevation of the male driver for the series.

Figure 5 is an axial section of a fastener, the female recess of which incorporates a 'pilot' or 'guide' cavity.

Figure 6 shows an axial section of a fastener incorporating a 'keyed' or non-standard recess.

Figure 7 is a plan view of a fastener with a special 'high-grip' female recess incorporating two elements.

Figure 8 is a plan view of a fastener with a plurality of sides where 'N' can be any number.

Referring to figure 1, a single hexagonal female recess is formed in the head of a fastener which is the smallest in the series. Figure 2 depicts an intermediate size of fastener in this series embodying an application of this invention. The female recess comprises an hexagonal torque receiving recess (1) surmounted by a larger hexagonal torque receiving recess (2). Figure 3 shows the largest size of fastener in the series, incorporating not only recesses (1) and (2) as previously mentioned but also the largest torque receiving recess (3).

Figure 4 shows a view of the end of the male driver for the whole series. The male driving elem nt (6) is the sole portion which engages with r cess (1) of the smallest fastener (7) during rotation. Portions (5) and (6) engage, recesses (2) and (1) in the intermediate

fastener (8) and all three portions of the driver (4), (5) and (6) ngage with recesses (3), (2) and (1) when rotating the largest fastener (9).

It will be noticed that, even at the waist of fasteners (8) and (9), the wall section of the fasteners is not excessively reduced. Also, there is no draw shown on the embodiments depicted in Figures 1 to 3 inclusive. Normally, fasteners (8) and (9) would require draw if conventional female recesses were employed, in view of the depth of the recesses.

Figure 5 depicts a fastener (10) provided with a female recess incorporating three stepped elements (11), (12) and (13) as well as a domed depression (14) at its base which may be engaged by a complementary portion on the male driver. Producing this depression also facilitates the production of a full head during cold heading.
Also, the complementary portion of the driver greatly assists axial alignment when entering the smallest element (13) of the recess. This depression need not necessarily be domed. The dashed line (15) indicates a predominantly conical base linking with a cylindrical pilot contiguous to the smallest element (13).

Figure 6 illustrates a fastener (16) provided with a keyed or 'coded' recess to correspond with a similarly configuration on the driver. The recess elements (17), (18) and (19) are of differing heights and, whereas elements (17) and (19) are hexagonal, the remaining element (18) is decagonal. The axial alignment of the various recesses can also be varied; so the system provides considerable potential for ensuring that 'coded' fasteners even though they may be similar in size to uncoded examples can only be removed by authorized personnel using the correct tools.

Figure 7 is a plan view of the head (20) of a fastener with a high-grip dual recess. The flanks of the recesses (21) and (22) are curved, as are those of the driver, to produce an enhanced frictional grip at the vertices of the forms. The driver alone may have curved flanks, engaging with straight sided recesses in the fastener. Use of such a stratagem ensures that the fastener is retained firmly on the driver, thus allowing easy spotting of the fastener in remote locations.

Figure 8 is a plan view of a fastener head (23) whereby the letter (N) indicates that the number of sides to the recess can be varied to accommodate different for example security configurations and uses.

CLAIMS

1. A driving head system for fasteners which comprises a method of transmitting torque to a range of differently sized fasteners using one driver and to the design of the punches which impart the particular recess to the fasteners and to the driving system.

2. A driving system as claimed in Claim 1 wherein the fastener can be inserted and tightened by means of a conventional screw driver, a robot, a power tool and a chuck type driver all of one size head.

3. A driving system is claimed in Claim 1 and Claim 2 which requires vastly reduced axial pressure to insert the fastener.

4. A driver system as claimed in any preceding claim, wherein the risk of 'cam-out' is almost eliminated and hence damage to the fastener.

5. A driving system is claimed in any preceding claim wherein the design will facilitate the driver freely carrying the fastener to the fastening location by means of frictional contact.

6. A driver and fastener system substantially as described herein with reference to the accompanying design Drawing Number HTB/1.

The Patent Office

Application No:	GB 9820519.8	**Examiner:**	Robert H Games
Claims searched:	1-6	**Date of search:**	18 January 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F2H

Int Cl (Ed.6): F16B 23/00

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2285940 A	(TURNER) see whole document especially page 5 line 30 to page 6 line 19	1-5
X	GB 1150382	(PODOLSKY) see whole document	1-5
A	US 3872904	(BARLOW) see Figs 1-4	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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